STINGS OF ANTS OF THE TRIBE PHEIDOLOGETINI (MYRMICINAE)

by

Charles Kugler

Biology Department, Radford University,
Radford, VA 24142 USA

The definition of the Tribe Pheidologetini in the ant subfamily Myrmicinae has always been problematic. Emery (1922) erected the tribe to contain the genera **Pheidologeton, Oligomyrmex, Aneleus, Lophomyrmex, Trigonogaster, Erebomyrma, Carebara** and **Paedalgus**, but Wheeler (1922) put all these genera in the Solenopsidini. Neither Emery nor Wheeler satisfactorily defined either tribe. More recently, Ettershank (1966) proposed the "**Pheidologeton** genus group" composed of **Pheidologeton, Oligomyrmex** (including most **Aneleus**), **Lophomyrmex, Carebara, Paedalgus** and **Anisopheidole**, but still uncertainty remains as to relationships of these genera and even the definitions of the genera themselves. New characters and new means of analysis are needed to help resolve this problem.

In earlier studies of the myrmicine sting apparatus (Kugler, 1978a, 1978b), I found that the eight sclerites constituting the sting apparatus are a rich source of characters that vary between genera. Moreover, the sting apparatus was generally uniform within those genera for which several species were examined. Thus, the sting apparatus holds promise for helping define myrmicine genera and analyzing phyletic relationships among them.

In this paper I describe and compare the sting apparatuses of **Pheidologeton, Oligomyrmex, Trigonogaster, Lophomyrmex,** and **Anisopheidole.** The first three were described in Kugler (1978a), but only on the basis of single species and few specimens. Here their descriptions are extended to better see how the sting apparatus varies between castes and between species within genera.

METHODS

Each sting apparatus was removed from the ant, cleared in hot lactophenol solution, and usually dissected further into two halves and a sting. Stings and sometimes whole apparatuses were mounted in glycerin jelly for ease of positioning and repositioning in exact lateral, dorsal and other views. The other sclerites were mounted in Canada balsam. For more details, see Kugler (1978a). Preparations were examined with a Zeiss KF-2 phase contrast microscope at 400X magnification. Drawings and measurements were made using a grid eyepiece, with estimated accuracy of $\pm$0.001mm. In measurement of regions of sting, the boundary between the sting shaft and valve chamber is the point of closest approximation of outer and innner walls at the posterior end of the valve chamber; the boundary between valve chamber and sting bulb is the anterior end of the internal apophysis. In **Oligomyrmex,** I could not discern precisely the end of the apophysis, so used instead the middle of the transverse ridge, which is near the end of the apophysis in other genera. The Index of Reduction (IR) is a measure of the length of the sting relative to the size of the ant: (pronotal W/sting L) X 100. Sensilla counts on gonostyli include the dorsoterminal chaeta and companion seta. Scale lines in all figures are 0.05mm.

Species examined: **Anisopheidole antipodum** (1 major, 1 minor) Australia: W. Australia, Manjimup, W. S. Brooks, leg. **Lophomyrmex bedoti** (5 workers) Indonesia: Kalimantan, Pleihari-Martapura Reserve, 3 July 1983, M. W. Moffett, leg. **Lophomyrmex opaciceps** (2 workers) Indonesia, W. Java, Ujung Kulon National Park, 1 Sept. 1983, M. W. Moffett, leg. **Pheidologeton diversus** (1 major, 1 media, 3 minors) Malaysia, Singapore, Botanic Gardens, 31 Oct. 82, M. W. Moffett and D. A. Fletcher, leg.; and N. Celebes, Tangkoko-Batuangus Res., W. L. Brown, leg. **Pheidologeton nanus** (1 major, 1 media, 2 minors) India, Kerala State, Periyar Tiger Preserve, 8 Mar. 82, M. W. Moffett, leg. **Pheidologeton pygmaeus** (2 majors, 3 minors) Malaysia, Penang, Penang Hill, colony #08-83, M. W. Moffett, leg. **Pheidologeton silenus** (1 major, 1 minor) Malaysia, Sarawak (1st Division) Samunsam Wildlife Sanct., May 28, 1983, M. W. Moffett, leg. **Oligomyrmex corniger**? (near **sodalis**) (1 major, 1 minor) New Caledonia, Mt. Mou, Dec. 10, 1954, #109, E. O. Wilson, leg. **Oligomyrmex overbecki** (2 major, 2 minor workers) Singapore, Botanic gardens,

December, 1983, M. W. Moffett, leg. **Oligomyrmex sp. 2** (1 major, 1 minor) Australia, N. Queensland, Eungella, B. Hölldobler, leg. **Oligomyrmex (Erebomyrma) urichi** (1 minor) Trinidad, Oropouche Cave near Cumaca, 18 June 1961, E. O. Wilson, leg. **Oligomyrmex (Nimbamyrmex) villiersi** (?) (1 minor) Belgian Congo, Ituri Forest vic., Epulu, July, 1955, No. 6, T. Gregg, leg. **Trigonogaster sp. 1** (2 workers) Indonesia, Central Sulawesi, Lore Lindu N. P. at Toro, 14 July, 1983, M. W. Moffett and D. A. Fletcher, leg. **Trigonogaster sp. 2** (1 worker) and **Trigonogaster recurvispinosa** (1 worker) Indonesia, Bali, Monkey forest at Ubud, 18 August, 1983, M. W. Moffett and D. A. Fletcher, leg. **Trigonogaster sp. 3** (2 workers) Malaysia, Gombak field station, November, 1983, M. W. Moffett and D. A. Fletcher, leg.

Vouchers of all species will be deposited in the Museum of Comparative Zoology, Harvard University with the label "VOUCHER Sting Dissection, Kugler 1984."

PHEIDOLOGETON

Majors of **P. silenus**; majors and medias of **P. diversus** and **P. nanus.**

Spiracular plate: (Fig. 1) Nearly square, larger than quadrate plate. Anterior apodeme not extending onto partially membranous medial connection. No posterodorsal lobe or dorsal notch. Posteroventral corner not elongate. Spiracle not enlarged. Apodeme wider in **P. nanus.** Posterodorsal corner of **P. diversus** media reduced and approaching condition in minors (Fig. 4).

Quadrate plate: (Fig. 1) Body wider than apodeme; anterior and dorsal ridges thick, forming a prominent, well sclerotized anterodorsal corner with lateral and medial lobes. In **P. silenus** and **P. nanus,** posterior edge of body with a concave notch in dorsal half; **P. diversus** not notched.

Anal plate: Much wider than long, with ill defined edges. Setae arranged as in minors (Fig. 4) along posterior margin in two lateral patches; 9 setae in **P. silenus** and **P. diversus**; 5-6 in **P. nanus.**

Oblong plate: (Fig. 1) Not divided into posterior and ventral arms by a postincision. Dorsal ridge with subterminal tubercle and long posterior apodeme. Anterior apodeme not especially elongate. Fulcral arm weakly sclerotized, oval. Sensilla: 3-6 intervalvifer, 3-9 ramal, 2-6 fulcral. Numbers can vary between two halves of same apparatus, and are generally larger in larger individuals.

Gonostylus: (Fig. 1) Wide basally, but abruptly narrowed midlength. No segmentation. Dorsoterminal chaeta and companion seta may be sparated from other sensilla by a gap, but generally not. Sensilla: 7-12 trichodea, 6-7 chaetica, 0-2 basiconica.

Triangular plate: (Fig. 1) Moderately wide-bodied; not elongate; no dorsal or medial tubercles.

Lancet: (Fig. 1) Short, weak; apex acute, flexible, lacking barbs. Two small valves per lancet; posterior valve highly reduced.

Sting: (Figs. 2,3) Sting shaft reduced in length (38-41% of sting length), weak, lacking campaniform sensilla; apex laterally compressed to form a flexible, spatulate flange. Flange larger in **P. diversus** and especially **P. nanus** (Fig. 3). Valve chamber 19-25% of sting L; profile distinct from sting bulb, but not from sting shaft; internal apophysis touches dorsal wall of sting. Sting wall at boundary between sting bulb and valve chamber thickened into a wide, transverse, internal ridge. Sting bulb 34-42% of sting L, very wide, but sharply tapered to narrow, weakly arched sting base with thick basal ridge. Bulb more vaulted in **P. diversus** major, approaching the shape of minors (Fig. 5) Basal notch very wide dorsoventrally. IR = 11-15.

Furcula: (Figs. 2,3) Reduced to a thick, subtriangular sclerite tightly fused to top of sting base. No dorsal arm.

Minors of **P. silenus, P. diversus**, and **P. nanus.**

Spiracular plate: (Fig. 4) More triangular than in major, due to reduction of posterodorsal corner.

Quadrate plate: (Fig. 4) Anterior edge concave. Body wider than apodeme, with notched posterior margin. Anterodorsal corner without lobes; pollicate in **P. diversus**, more elongate in **P. silenus** (Fig. 4) and **P. nanus.**

Anal plate: (Fig. 4) Posterior margin more convex than in major; with fewer (3-5) setae.

Oblong plate: (Fig. 4) Shape like that of major. Sensilla: 2 intervalvifer, 1 ramal, 0 fulcral.

Gonostylus: (Fig. 4) Same basic shape as in major, but narrow distal portion shorter. Fewer sensilla than in major: 5-7 trichodea, 2-3 chaetica, 0 basiconica.

Triangular plate: (Fig. 4) Body more slender than in major.

Lancet: (Fig. 4) As in major, but with single, highly reduced valve.

Sting: (Fig. 5) Sting shaft short; seems to retain small apical flange, but possibly not (see Kugler 1978a, Fig. 235). Valve chamber even less distinguishable from sting shaft than in majors. Sting bulb more vaulted in lateral view; without internal ridge. Total sting L (relative to body size) similar to majors (IR = 12-14), but sting bulb proportionately longer (51-56% of sting L) at expense of shorter valve chamber (11-17%) and sting shaft (30-33%).

Furcula: (Fig. 5) A transverse bar fused to the dorsal side of sting base, with narrower extremities extending onto sides.

Major and minor of **Pheidologeton pygmaeus.**

Spiracular plate: (Fig. 6) Smaller than quadrate plate; shape subtriangular due to reduction of posterodorsal corner. Body weakly sclerotized, grading into membranous medial connection. Posteroventral corner notched. Spiracle small.

Quadrate plate: (Fig. 6) Weakly sclerotized; ventral end much narrower than dorsal end. Apodeme mostly wider than body; anterodorsal corner lightly sclerotized, short, without lobes. Body grades into membrane caudally and dorsally.

Anal plate: Longer than wide, with weakly defined perimeter. Posterior margin with 8-9 long, evenly spaced setae.

Oblong plate: (Fig. 6) Not divided into posterior and ventral arms by a postincision. Dorsal ridge narrow, its distal end tapered; no subterminal tubercle. Body weakly sclerotized, grading into membrane caudally. Fulcral arm short, weak, spindle-shaped. Sensilla: 3 intervalvifer, 3 ramal, 0 fulcral.

Gonostylus: (Fig. 6) Slender, single-segmented, uniformly sclerotized except for membranous apical flange. Sensilla bimodally distributed with dorsoterminal chaeta and companion seta isolated at apex. Sensilla: 1-4 trichodea, 2 chaetica, 0 basiconica.

Triangular plate: (Fig. 6) Body slender; no dorsal or medial tubercles.

Lancet: (Fig. 6) Long, slender, moderately sclerotized; apex tapered to sharp point with single small barb. Dorsal ridge indistinct. Lancet valves large, one per lancet.

Sting: (Fig. 7) Sting shaft long (59-60% of sting L) slender, straight, and acute; proximal half with 2-3 pairs of campaniform sensilla; no terminal flange. Valve chamber long (25-27% of sting L) and high, its profile distinct from sting shaft, internal apophysis held away from dorsal wall of sting by a narrow internal ridge. Sting bulb short (14% of sting L); not higher than valve chamber. Sting base in ventral view convex, without anterolateral processes. Basal ridge present, weakly arched in anterior view. Relative to body size, sting longer in minors than in majors (IR minors = 72, majors = 53).

Furcula: (Fig. 7) Ventral arms tightly fused to sting base. Dorsal arm large, projecting anteriorly.

OLIGOMYRMEX

Majors of **O. corniger, O. overbecki,** and **O. sp. 2**

Spiracular plate: In **O. sp. 2** and **O. corniger** (Fig. 8A), large, oval, with posterodorsal corner. Anterior apodeme narrow; medial connection membranous. Spiracle small, near center of plate. Plate of **O. overbecki** more triangular and with larger spiracle, much as in minor of **O. corniger** (Fig. 8B).

Quadrate plate: (Fig. 8A) Apodeme and body subequal in width, posterior margin not notched. Anterodorsal corner thickened, but without lobes; corner shape differs in different species: pollicate in **O. corniger** (Fig. 8A); as long, but narrower in **O. overbecki**; reduced to a broadly rounded corner in **O. sp. 2.**

Anal plate: Shape subtriangular. Sensilla marginal, in two lateral patches. With two setae in **O. overbecki**; four in **O. corniger**; number unclear in **O. sp. 2.**

Oblong plate: Very similar in the three species, and much like that of **Pheidologeton pygmaeus** (Fig. 6). Not divided into posterior and ventral arms by a postincision. Posterior apodemes long. Fulcral arm weak, spindle-shaped, with poorly defined dorsal limb. Sensilla: 2-3 intervalvifer, 3-6 ramal, 0 fulcral.

Gonostylus: As in **P. pygmaeus** (Fig. 6). Single segmented, short, tapered in distal half. Dorsoterminal chaeta and companion seta present in **O. corniger** and **O. sp. 2**; companion seta not present in **O. overbecki.** Sensilla: 2-6 trichodea, 2 chaetica, 0 basiconica.

Triangular plate: Shape in all three species as in **P. pygmaeus** (Fig. 6). No medial or dorsal tubercles.

Lancet: Strong and acute as in **P. pygmaeus** (Fig. 6), but with more reduced, barely visible barb. Two valves per lancet in **O. corniger** and **O. sp. 2**; only one visible in **O. overbecki.**

Sting: In **O. corniger** (Fig. 9) and **O. sp. 2** tapered from base to apex, valve chamber and sting bulb without distinct profiles. Sting shaft long (61% of sting L), strong, acute. Campaniform sensilla present in **O. corniger** and **O. sp. 2.** Valve chamber very low, 21% of sting L, separated from sting bulb by a large, transverse internal ridge. Sting bulb very short (18% of sting L), with large basal notch and narrow sting base. In **O. overbecki** majors (Fig. 11), valve chamber more vaulted and articular processes more slender than in other species, but lengths of parts are similar (sting shaft = 60% of sting L, valve chamber = 21%, and sting bulb = 19%).

Furcula: (Figs. 9,10) A bar tightly fused to top of sting base in all three species.

Minor workers of **O. corniger, O. overbecki, O. sp. 2, O. villiersi,** and **O. urichi.**

Spiracular plate: Triangular in **O. corniger** (Fig. 8B), **O. overbecki,** and **O. urichi,** due to reduced posterodorsal corner; spiracle near posterior edge. Spiracle in **O. corniger** and **O. overbecki** large relative to size of plate. Anteroventral corner elongate in **O. urichi.** Plate poorly preserved in **O. sp. 2** and **O. villiersi** preparations.

Quadrate plate: In **O. corniger, O. sp. 2,** and **O. villiersi,** similar to that of **O. corniger** major (Fig. 8A). Anterodorsal corner in **O. overbecki** narrower, as in the **O. overbecki** major. Anterodorsal corner in **O. urichi** elongate as in the minor of **Pheidologeton silenus** (Fig. 4)

Anal plate: Shape triangular in **O. overbecki;** unclear in others. In **O. corniger, O. urichi,** and **O. villiersi,** with 2-3 marginal, laterally placed setae, as in minor of **P. silenus** (Fig. 4).

Oblong plate: In **O. corniger, O. overbecki, O. urichi,** and **O. villiersi** as described for majors, except for lack of a dorsal extension of fulcral arm. Sensilla: 2 intervalvifer, 1-5 ramal, 0 fulcral.

Gonostylus: Shape in all species much like that of **P. diversus** minor worker (Fig. 4). All but **O. urichi** with a gap separating dorsoterminal chaeta and companion seta from others. Sensilla: 4-5 trichodea, 1-2 chaetica, 0 basiconica in **O. corniger, O. villiersi,** and **O. urichi;** others unclear.

Triangular plate: All species as in majors, except for **O. urichi,** in which body is unusually narrow.

Lancet: Strong, acute as in majors, except for **O. urichi,** in which it is shorter, with a weak, acute apex and no trace of a barb.

Sting: **O. overbecki, O. sp. 2,** and **O. villiersi** with stings like that of major of **O. overbecki** (Fig. 11). **O. corniger** (Fig. 10) similar, but with narrower basal notch (Fig. 10 is a refinement of Figs. 233-234 in Kugler 1978a). **O. urichi** (Fig. 12) has a much shorter, weaker sting shaft (40% of sting L, compared to 52-59% in other species), a relatively large sting bulb, and no internal ridge. None have campaniform sensilla.

Furcula: (Figs. 10,11,12) In all species, reduced to a small sclerite tightly fused to the sting base.

LOPHOMYRMEX

Monomorphic workers of **L. bedoti** and **L. opaciceps.**

Spiracular plate: (Fig. 13) Triangular in **L. bedoti** (Fig. 13) to subtriangular in **L. opaciceps** due to reduction of posterodorsal corner. Anterior apodeme narrow, but forming a sclerotized medial connection between hemitergites. Posteroventral corner narrow and elongate. Spiracle large.

Quadrate plate: (Fig. 13) Tapered ventrally. Apodeme area in **L. bedoti** subequal to area of body; in **L. opaciceps,** twice the width of the body. Posterior edge not notched. Anterodorsal corner prominent, wide, with small medial lobe.

Anal plate: Slightly wider than long, with indistinct margins. Posterior margin with 6 to 8 long setae in two clusters separated by a weak median gap.

Oblong plate: (Fig. 13) Divided into distinct posterior and ventral arms by a postincision. Posterior arm with slender dorsal ridge terminating as a long posterior apodeme that nearly connects medially with its counterpart; no subterminal tubercle present. Anterior apodeme long and slender. Fulcral arm large, extending to postincision, anterior edge ridged. Sensilla: 1-2 intervalvifer, 2 ramal, 0 fulcral.

Gonostylus: (Fig. 13) Single segmented, uniformly sclerotized. Slender, evenly tapered in lateral view, but markedly narrowed midlength in dorsal view. Long membranous terminal flange present. Sensilla bimodally distributed; dorsoterminal chaeta and companion seta may be isolated or accompanied by 1-2 shorter setae; some basal setae may be very long. Sensilla: 5-8 trichodea, 1-2 chaetica, 0-1 basiconica.

Triangular plate: (Fig. 13) Body and lobes slender. No dorsal or medial tubercles.

Lancet: (Fig. 13) Long and gradually tapered to very acute, but weak apex. **L. bedoti** with two small valves per lancet, the posterior valve reduced (Fig. 13); **L. opaciceps** with one valve.

Sting: (Fig. 14) Sting shaft long, slender, very weak, twisted in all preparations. Sides taper and disappear subterminally, beyond which the dorsal wall dilates slightly in both lateral and ventral views then ends with a short truncate shelf. One pair of campaniform sensilla at base of sting shaft. Valve chamber low, its profile indistinct from the sting shaft and sting bulb. Junction of valve chamber and sting bulb with large tubercle projecting down from the dorsal wall. Sting bulb long, but not especially wide, oval in ventral view; basal notch long, low; articular processes small. Sting base narrow, weakly arched in anterior view, basal ridge lost medially. Sting proportions: Sting shaft = 48% of sting L, valve chamber = 15%, sting bulb = 36%. IR = 27.

Furcula: Reduced to a bar fused to the sting base. Narrow in **L. bedoti** (Fig. 14), wider and more shelf-like in **L. opaciceps.**

TRIGONOGASTER

Monomorphic workers of **T. recurvispinosa** and 3 unidentified species.

None of these differs significantly from the single **T. recurvispinosa** worker described by Kugler (1978a:472-473, Figs. 186-187), so I will only supplement that description. Anal plate a little wider than long, with broadly rounded posterior margin; 4-9 marginal to submarginal setae, with little or no median gap. Anterodorsal corner of quadrate plate short, narrow, without lobes. Gonostylus from above wide at base, evenly tapered to broadly rounded apex with long membranous extension; 5-6 long sensilla trichodea, 1 s. chaetica, 0 basiconica; no gap separating dorsoterminal chaeta and companion seta from others; microtrichae on medial side of gonostylus very long and dense. Lancet apex spatulate, but not enlarged. Sting with small internal tubercle of same shape and position as in **Lophomyrmex** (Fig. 14); sting base in some species with small anterolateral processes as in **Crematogaster** (Kugler 1978a, Fig. 184).

ANISOPHEIDOLE

Major and minor of **A. antipodum.**

Spiracular plate: (Fig. 15) Posterior and dorsal sides merge, eliminating posterodorsal corner. Medial connection between hemitergites sclerotized. Spiracle in center of plate, not enlarged.

Quadrate plate: (Fig. 15) Anterodorsal corner especially broad and prominent, making whole anterior edge of plate concave. No medial or lateral lobes.

Anal plate: Weakly sclerotized with ill-defined perimeter; about three times wider than long. Setae located medially on posterior margin; contrary to the rule, more in the minor (5) than the major (2).

Oblong plate: (Fig. 15) Not split into posterior and ventral arms by a postincision. Dorsal ridge strong, gradually widening caudad, forming a shelf that, seen from above, looks much like a right triangle; no subterminal tubercle or distinct posterior apodeme. Anterior apodeme thick, blunt. Fulcral arm short, thin, spindle-shaped in major; unclear in minor. Sensilla: 2 intervalvifer, 6 ramal in major, 4 ramal in minor, 0 fulcral.

Gonostylus: (Fig. 15) Single segmented; distal two thirds tapered to narrow tip. Sensilla distributed without gaps; dorsoterminal chaeta present in minor, not detectable in major; no obvious companion seta. Sensilla: major with 10-13 trichodea, 3-4 chaetica, 5-6 basiconica; minor with 11 trichodea, 1 chaetica, 2 basiconica.

Triangular plate: Body thick, nearly square in major (Fig. 15); more slender in minor.

Lancet: (Fig. 15) Tip acute, but weakly sclerotized, probably unable to pierce; one valve per lancet.

Sting: (Fig. 16) Sting shaft long (49-53% of sting L) slender, acute, but weakly sclerotized; with one pair of campaniform sensilla. Valve chamber short (13% of sting L), low, with weakly differentiated profile. Sting bulb long (33-38% of sting L), low in side view; very wide, nearly square in ventral view; with no internal ridges or tubercles. Sting base arched in anterior view, with wide basal ridge. IR = 21 in the major; 36 in the minor.

Furcula: (Figs. 15, 16) Arched, transverse, articulating with anterolateral processes of sting base. No dorsal arm.

DISCUSSION

Variation within Genera

Intercaste variation in **Pheidologeton** is strong in **P. nanus, P. diversus**, and **P. silenus**, especially in shapes of the spiracular plate, quadrate plate, gonostylus and sting, and in numbers of sensilla, which appear correlated with ant size.

Little interspecific variation is seen between **P. silenus, P. diversus** and **P. nanus**, and most of that is in the major caste. Differences occur mainly in the sizes and shapes of the spiracular plate, the sting shaft flange, and the furcula.

In contrast, the apparatus of **P. pygmaeus** differs substantially from those of the other **Pheidologeton** in the following ways: 1) it is monomorphic, 2) the spiracular plate is smaller than the quadrate plate and its shape is subtriangular even in the majors, 3) the quadrate plate lacks medial and lateral lobes even in majors, 4) the anal plate is longer than wide, rather than transverse, and has no median gap in the setae, 5) the base of gonostylus is narrower, 6) there is only a single pair of lancet valves, which are much larger than in other **Pheidologeton** examined, 7) the lancets are strong, sharp, and barbed, 8) the sting shaft is strong, piercing, and without a terminal flange, 9) the valve chamber is much larger, and 10) the furcula has a prominent dorsal arm. The differences in sting and lancets indicate that **P. pygmaeus** can sting, but not **P. silenus, P. diversus**, or **P. nanus**. This is confirmed by Mark W. Moffett, who says that **P. pygmaeus** has a "vicious sting," whereas the other **Pheidologeton** discussed here do not sting at all (personal communication). The flange on the sting shaft of **P. nanus, P. diversus**, and **P. silenus** is probably for airing or applying a defensive fluid.

Intercaste variation in **Oligomyrmex** can be discussed for three species. In **O. overbecki** there is very little difference between majors and minors in characteristics of the quadrate plate, anal plate, oblong plate, triangular plate, lancet, sting or furcula. Lack of a good spiracular plate preparation for the major prevents comparison. In **O. corniger** and **O. sp. 2** there is marked dimorphism in some sclerites: 1) the spiracular plate is oval in the majors of **O. corniger** and triangular in the minors, 2) the anterodorsal corner of the quadrate plate in **O. sp. 2** minors is longer than in majors; 3) in both species the fulcral arm of the oblong plate is shorter and weaker in the minors, and 4) in both species the shapes of the valve chamber and sting bulb are much different in the two castes.

The variation between species of **Oligomyrmex** ranges from little to marked. **O. corniger** and **O. sp. 2** are very nearly identical in sting apparatus morphology, except for the shape of the anterodorsal corner of the quadrate plate in the majors. **O. overbecki** differs from those two species only in having the sting of the major the same as the minor. The lack of a stronger sting in the majors of **O. overbecki** may be a function of size, since these majors are about the same size as the minors of **O. sp. 2**. For the remaining two species the major worker was unavailable for study. The sting apparatus in the minor of **O. villiersi** is like that of **O. sp. 2**, but the apparatus of **O. urichi** minors differs from those of the other four species in a number of ways: 1) the anterodorsal corner of the quadrate plate is more elongate and digitate, 2) the gonostylus lacks the gap between distal and proximal sensilla, 3) the triangular plate is much narrower, 4) the lancet has a flexible, more abruptly tapered apex, and 5) the sting lacks a transverse internal ridge and has a shorter, weaker sting shaft. These characteristics of **O. urichi** look like typical reductions in the apparatus with loss of the stinging function.

Lophomyrmex has monomorphic workers, and only one species was examined. The five workers of that species varied only in numbers of sensilla.

Trigonogaster workers are also monomorphic, and in the four species examined the sting apparatus varied only slightly in shape of the spiracular plate and in the numbers and positions of sensilla.

Anisopheidole contains only the species **antipodum**. The one major and one minor examined differed slightly in: 1) numbers of sensilla, 2) thickness of the triangular plate, 3) proportions within the sting (majors with a slightly longer sting bulb and slightly shorter sting shaft), and 4) the index of reduction (sting relatively larger in minors).

Comparisons of Genera

Oligomyrmex and **Pheidologeton** (excluding **P. pygmaeus**) share several sting apparatus characters that are advanced within the Myrmicinae: 1) the sting bulb wide at the articular processes, but tapering sharply to a narrow sting base with a similarly shaped and positioned furcula, 2) the dorsoventrally wide basal notch, and 3) the transverse

internal ridge (though somewhat different in shape and position), 4) the oblong plate without a postincision and with a short, spindle-shaped fulcral arm, and 5) the partly membranous medial connection between the spiracular plates. These characters are thus far a unique combination of characters within the Myrmicinae, even though the sting bulb form (character 1 above) is found in **Myrmecina**, the internal ridge of the sting is found in **Proatta, Cardiocondyla, Tranopelta**, and **Myrmicaria**, and the membranous medial connection of the spiracular plates is found in a variety of genera (Kugler 1978a, Appendix A1). Among most species examined, **Oligomyrmex** and **Pheidologeton** generally differ markedly in strength and form of their sting shafts and lancets and in the form of the quadrate plates of the minor workers, but the apparatus of the **O. urichi** minor (Fig. 12) is much like that of a **Pheidologeton** minor (Fig. 5). This strong similarity of the sting apparatuses of **Oligomyrmex** and **Pheidologeton** supports the views of Emery (1922), W. M. Wheeler (1922), Wheeler and Wheeler (1953), and Ettershank (1966) that these are closely related genera.

I have separated **Pheidologeton pygmaeus** from the other three **Pheidologeton** because of differing opinions on the generic placement of this species. According to Emery (1922) **pygmaeus** belonged in **Aneleus**, but then Ettershank (1966) transferred **pygmaeus** to **Pheidologeton** and the other **Aneleus** species to **Oligomyrmex**. Looking at the sting apparatus, there are many striking differences between the **pygmaeus** and the other **Pheidologeton**. Most of these are due to the retention of a primitive stinging sting apparatus in **pygmaeus** while the other three species have acquired stings modified for chemical defense. I do find three derived characters in common, but these could easily be convergences: the fused furcula, membranous medial connection of the spiracular plates, and the lack of a postincision. **P. pygmaeus** seems more similar to **Oligomyrmex**, partly because most species of the latter that I examined also had piercing stings. In fact, the **pygmaeus** sting would look a lot like that of **O. overbecki** if its valve chamber and furcula were smaller. However, some characteristics shared with **Oligomyrmex** may be derived: the same shape and position of the transverse internal ridge in the sting bulb, and the structure of the oblong plate (in addition to the furcula, spiracular plate and postincision characteristics mentioned above that **pygmaeus** also shares with **Pheidologeton**). This comparison of the sting apparatus would indicate somewhat greater affinities of **pygmaeus** with **Oligomyrmex** than with **Pheidologeton.**

The sting apparatuses of the two **Lophomyrmex** species examined are not clearly allied with those of either **Pheidologeton** or **Oligomyrmex.** It does share some derived characters with **Pheidologeton**, such as weak sting and lancets, and (with **Oligomyrmex** also) lack of a dorsal arm on the furcula, but these are common convergences that occur whenever the stinging function is reduced or lost. On the other hand, the internal tubercle in the sting is an unusual feature that is found in **Myrmicaria, Tranopelta** (Kugler 1978a, Figs. 175, 230), and **Trigonogaster. Myrmicaria** and **Tranopelta** stings otherwise do not resemble that of **Lophomyrmex**, but the apparatus of **Trigonogaster** does in some ways: the form of the sting bulb in lateral and ventral views, the long, flexible, often twisted sting shaft, and the enlarged spiracle. These comparisons of the sting apparatus support the conclusions of Wheeler and Wheeler (1953), who, after comparing pheidologetine larvae, distanced **Lophomyrmex** from **Oligomyrmex** and **Pheidologeton** somewhat by putting it in a separate subtribe with **Trigonogaster.**

The **Trigonogaster** apparatus, in turn, seems most related to that of **Crematogaster.** The spiracular, quadrate, oblong plates and furcula in these two genera are very similar (Kugler 1978a:472-473), as are the lancets and sting base. **Crematogaster minutissima** also has a median tubercle in the sting like **Trigonogaster.** The **Crematogaster** gonostyli, however, do not have the long sensilla and extraordinarily long microtrichae found in the four **Trigonogaster** species.

The apparatus of **Anisopheidole antipodum**, has more similarities with those in the **Pheidole** genus group (Kugler 1978a) than with the other genera discussed here. For example, the sting in ventral view is much like that of **Messor**, and in lateral view is similar to **Stenamma**'s (Kugler 1978a, Figs. 139, 146). The gonostylus and lancets also resemble those in some members of the **Pheidole** group. Ettershank (1966) put **Anisopheidole** in the Pheidologetini, primarily on the strength of a wing venation character, but as Brown (1953) pointed out, **Anisopheidole**'s external morphology shows "...certain features in common with **Pheidole** and **Stenamma.**" Indeed, it was long considered a subgenus of **Pheidole.** Since sting apparatus morphology also shows features in common with the **Pheidole** group, we might reevaluate **Anisopheidole**'s present position near **Pheidologeton.**

It would be premature to try to characterize the "pheidologetine sting apparatus" or to say what genera belong in the Pheidologetini, since I have not been able to study all the necessary genera, and because of the diversity of stings among the genera examined. However, the following conclusions do seem warranted and should be useful to future reviewers of the tribe. On the basis of the sting apparatus alone: 1) **Pheidologeton** and **Oligomyrmex** are closely related, 2) **Pheidologeton pygmaeus** is closer to **Oligomyrmex** than to **Pheidologeton**, 3) **Lophomyrmex** and **Trigonogaster** seem related and possibly closer to **Crematogaster** than to **Pheidologeton** and **Oligomyrmex**, and 4) **Anisopheidole** has more affinities with the **Pheidole** genus group (sensu Kugler 1978a) than with **Pheidologeton** and **Oligomyrmex**.

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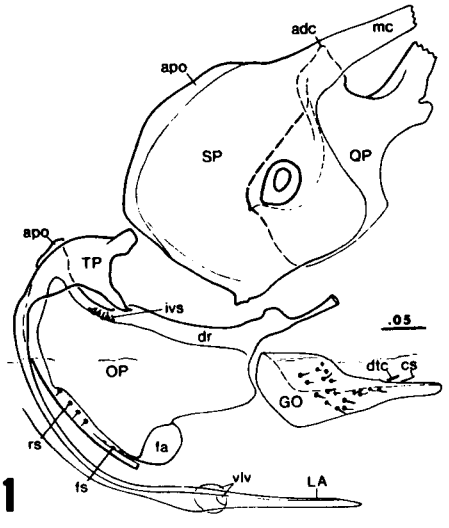

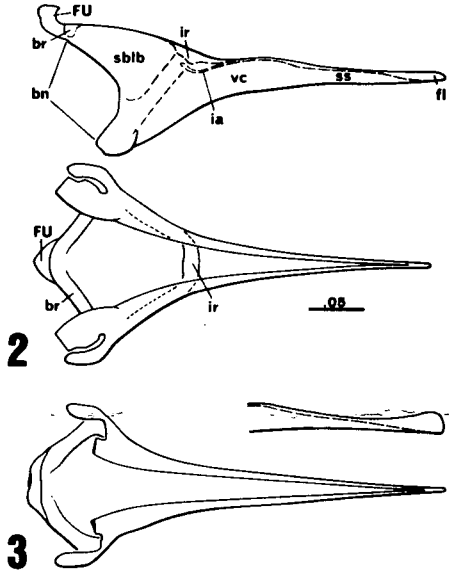

Figs. 1-3. **Pheidologeton silenus** and **Pheidologeton nanus** major workers. 1. Right half of **P. silenus** sting apparatus minus sting and furcula. Spiracular and quadrate plates separated from the triangular plate; gonostylus in ventrolateral view. 2. **P. silenus** sting and furcula in lateral view (above) and ventral view (below). 3. **P. nanus** sting shaft in lateral view; sting and furcula in ventral view. Abbreviations (names of sclerites in upper case): adc, anterodorsal corner of quadrate plate; apo, apodeme; bn, basal notch; br, basal ridge; cs, companion seta; dr, dorsal ridge; dtc, dorsoterminal chaeta; fa, fulcral arm; fl, flange; fs, fulcral sensilla; FU, furcula; GO, gonostylus; ia, internal apophysis; ir, internal ridge; ivs, intervalvifer sensilla; LA, lancet; mc, medial connection of spiracular plates; OP, oblong plate; QP, quadrate plate; rs, ramal sensilla; sblb, sting bulb; SP, spiracular plate; ss, sting shaft; TP, triangular plate; vc, valve chamber; vlv, valves of lancet.

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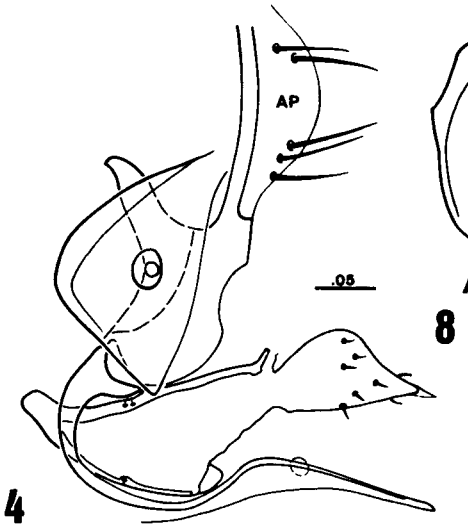
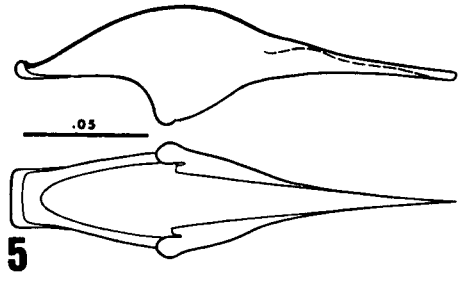
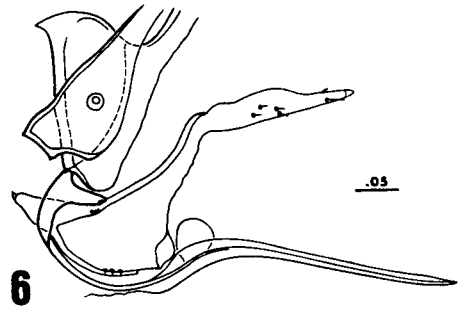
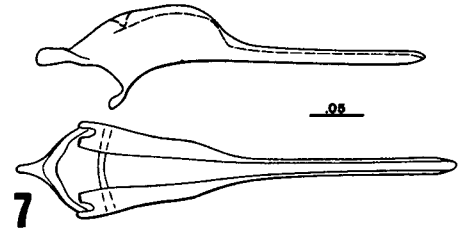


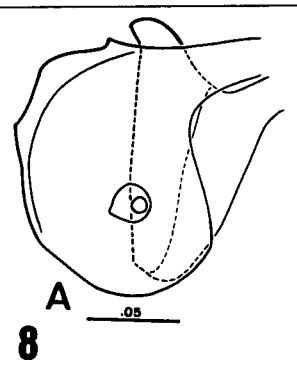


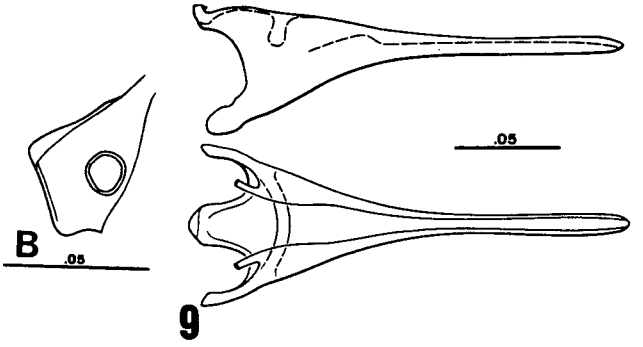
Figs. 4-5. **Pheidologeton silenus** minor worker. 4. Right side of sting apparatus minus sting and furcula. 5. Sting and furcula in lateral view (above) and ventral view (below). Abbreviation: AP, anal plate.

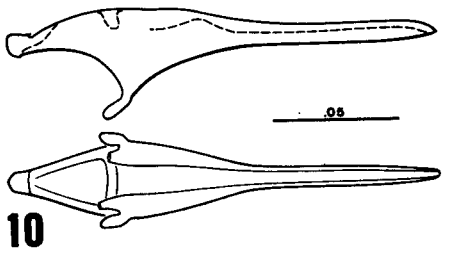


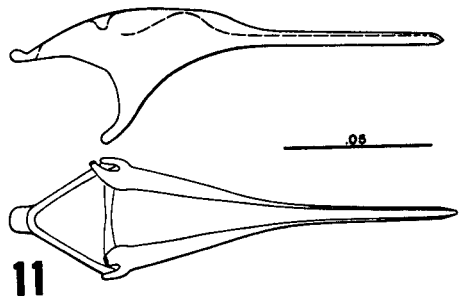


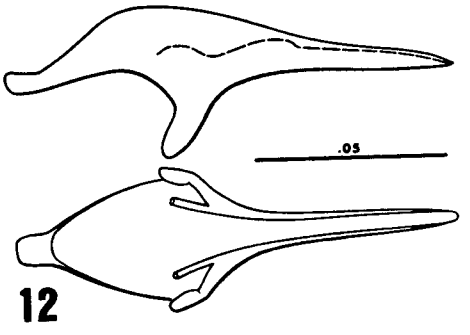
Figs. 6-7. **Pheidologeton pygmaeus.** 6. Right side of minor worker sting apparatus minus sting and furcula; gonostylus in ventral view. 7. Lateral view, sting and furcula of minor worker (above); ventral view, major worker (below).



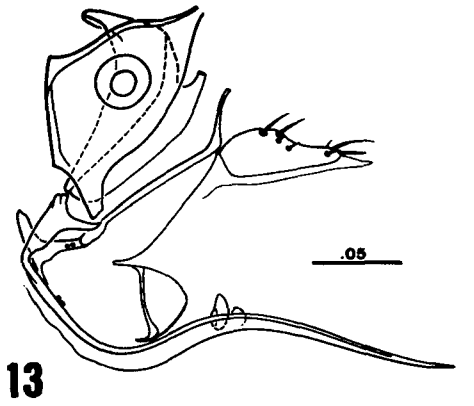


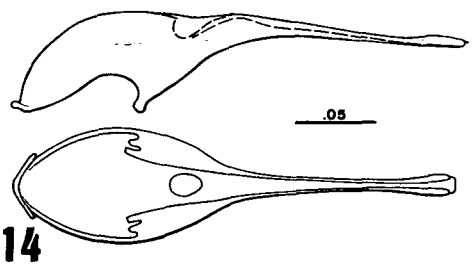




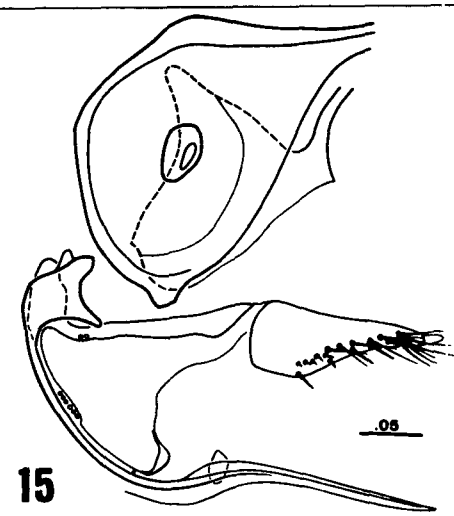


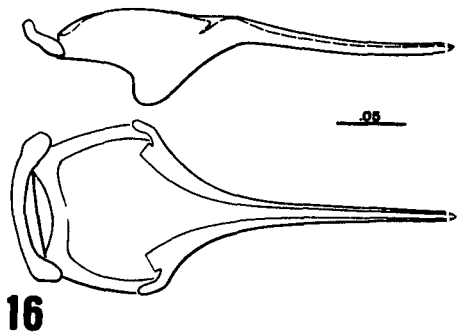
Figs. 8-12. **Oligomyrmex.** 8. **O. corniger.** A. Spiracular and quadrate plate of major worker. B. Spiracular plate of minor worker. 9. **O. corniger** major worker sting and furcula in lateral view (above) and ventral view (below). 10. **O. corniger** minor worker sting and furcula in lateral and ventral views. 11. **O. overbecki** major worker sting and furcula in lateral and ventral views. 12. **O. urichi** minor worker sting and furcula in lateral and ventral views.





Figs. 13-14. **Lophomyrmex bedoti** 13. Right side of sting apparatus minus sting and furcula; gonostylus in ventral view. 14. Sting and furcula in lateral view (above) and ventral view (below).





Figs. 15-16. **Anisopheidole antipodum.** 15. Right side of sting apparatus minus sting and furcula; gonostylus in dorsal view. 16. Sting and furcula in lateral view (above) and ventral view (below).